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AMENDMENT NO. 1 AUGUST 1993
TO
IS 2800 (Part 2) : 1979 CODE OF PRACTICE FOR CONSTRUCTION AND TESTING OF TUBEWELLS

PART 2 TESTING

(First Revision)

Addendum

(*Page* 5, *clause* 5.4) — Add the following new sub-clause:

'**5.4.1** Illustrative example for calculating the specific gravity and well efficiency of the tubewell is given in Appendix C.

APPENDIX C

(*Clause* 5.4.1)

Example:

A gravel packed slotted tubewell delivering discharge of 150 m^3/h at a depression of 5 m. The strata tapped is medium sand (size of sand $D50$) of 25 m of thickness with the grain size $d_{10} = 0{\cdot}25$ mm. The diameter of well pipe is 20 cm and the thickness of gravel pack is 15 cm.

Solution:

As per Hazen's formula

$K = c_x (d_{10})^2$

where K = coefficient of permeability m/day,

c = constant whose average value is taken as 850,

d_{10} = grain size in mm, and

$K = 850 \times (0{\cdot}25)^2 = 53{\cdot}125.$

The value of R, radius or influence, for medium sand may be taken as 250 m

$m = 25$

$rw = \frac{20}{2} + 15 = 25 \text{ mm} = 0{\cdot}25 \text{ m}$

depression $S = 5$ m

Theoretical specific gravity $O/S = 2\ \mathrm{Km}/\mathrm{logo}\frac{R}{rw}$

$$= \frac{2 \times 53{\cdot}125 \times 25}{2.3 \log^{10} \frac{250}{0{\cdot}25}}\ \mathrm{m^3/day/m}$$

$$= \frac{2 \times 53{\cdot}125 \times 25}{2{\cdot}3 \times 3 \times 24}\ \mathrm{m^3/h/m}$$

$$= 50{\cdot}37\ \mathrm{m^3/h/m}$$

Observed specific gravity $= 150/5 = 30\ \mathrm{m^3/h}$

Therefore, well efficiency $= 30/50{\cdot}37 = 59{\cdot}55$
$= 60\%$'

(HMD 20)

Reprography Unit, BIS, New Delhi, India

UDC 628·112·24 [illegible] : 006·76

Third Reprint FEBRUARY 2005
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(Reaffirmed 2003)

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION AND TESTING OF TUBEWELLS

PART II TESTING

(First Revision)

Pumps Sectional Committee, EDC 35, Code of Practice for Tubewell Drilling Subcommittee, EDC 35 : 4 [Ref : Doc : EDC 35 (2328)]

1. Scope — This part covers the following tests:

a) Measurement of tubewell depth,
b) Measurement of water level,
c) Verticality and alignment of tubewells,
d) Testing for yield and draw down, and
e) Quality of water.

2. Measurement of Tubewell Depth

2.1 *Measurement by Means of Cables or Rods* — This method is suitable for measurement of depth of tubewells on a consolidated formation.

The bottom of tubewell shall first be cleaned and the depth measured by:

a) twisted metallic cable strained by a plumb-bob, and
b) means of rigid rods.

With any of the above methods three distinct measurements shall be taken and effective one will be the average reading of the three.

If the depth of tubewell does not exceed 100 m, the accuracy of measurement is ± 0·5 percent. If the depth exceeds 100 m, the accuracy of measurement shall be agreed between contractor and owner.

2.2 *Measurement by Means of Casing* — This method also applies to unconsolidated formations and is used for any tubewell with casing. The depth of tubewell shall be deemed to be equal to length of the pipes lowered, after the deduction of the screwed ends. Each pipe should be measured to an accuracy of ± 0·1 percent. The accuracy of measurement is ± 0·3 percent.

3. Measurement of Water Level

3.1 *Direct Measurement* — This is carried out by a steel tape or cable with a suitable sinker attached at the end. The steel tape or cable is wound round a rotating drum. Measurements shall be done by measuring the length of tape or cable. Depth of immersion of sinker shall be taken into account in the measurement. A set of three readings shall be taken and effective will be their average. Any measurement which deviates from the average by more than ± 0·3 percent shall be discarded and new measurement to be taken in place. Accuracy of measurement shall be as agreed between the drilling agency and owner.

3.2 *Electric Measurement (Double-Pole Contact)* — Double-pole contact (*see* Fig. 1), a sufficiently rated battery, a reel with a length of twin electric cable and an electrical indicating instrument as a high resistance voltmeter or a milliammeter are required. The items should be adjusted as shown in the figure. One end of the cable shall be permanently connected to voltmeter/ammeter and the other end to be connected through battery. As the cable is lowered into the tubewell the circuit is completed as soon as the two electrodes strike the water and the instrument indicates. The depth of water level is obtained by measuring the twin cable from the electrodes to the top of tubewell.

Wherever electric power is more easily available, battery may be replaced with the power supply mains. In this case, single-pole method may be used. For single-pole contact, the apparatus is similar to as described for two-pole contact with the difference that the contact casing is fitted with one electrode and a single cable. The circuit is completed through the rising main as soon as the electrode touches the water. Measurement is similar to two-pole contact method. This method shall be employed only when the casing extends from the top of the bore hole to below the water surface to be measured.

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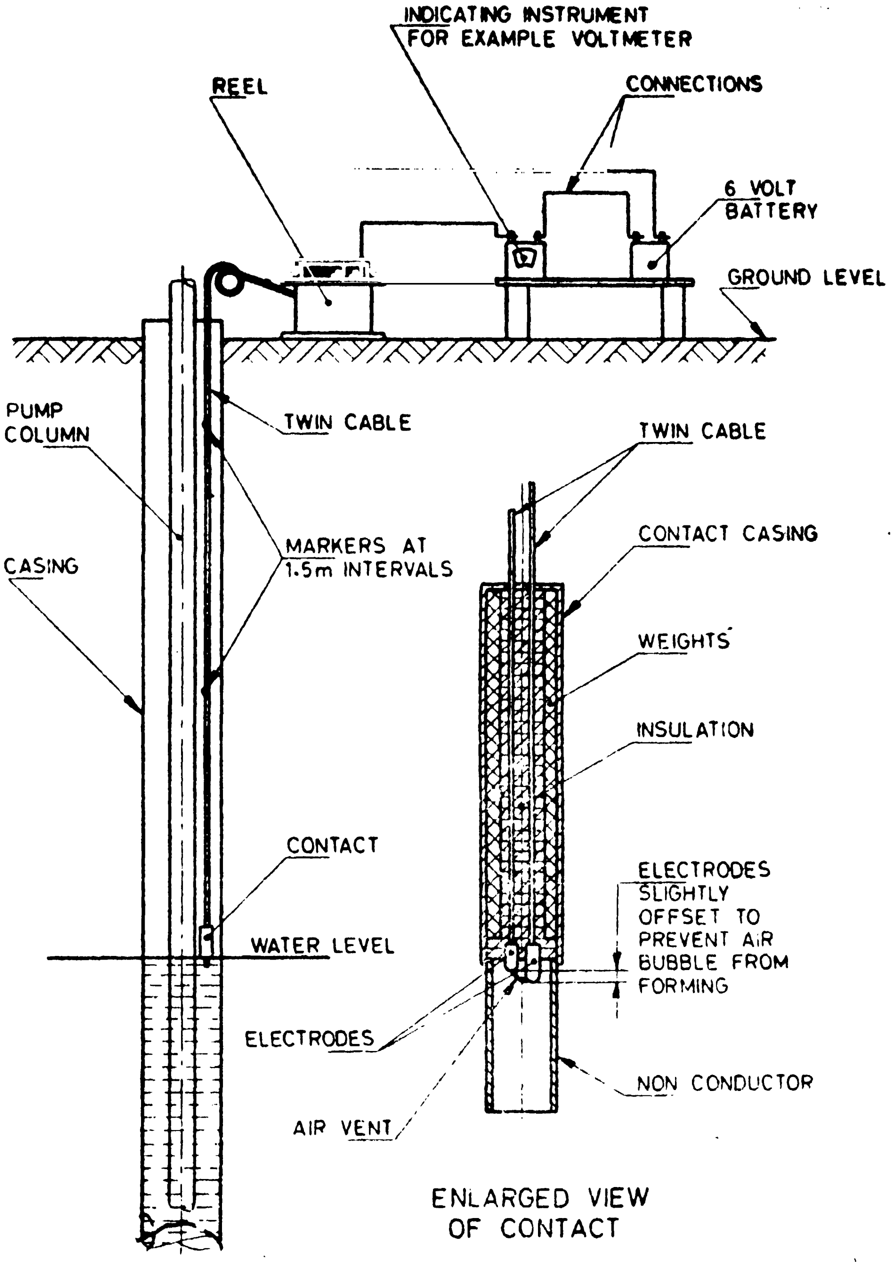


FIG. 1 ELECTRICAL APPARATUS WITH DOUBLE-POLE CONTACT FOR DETERMINING THE WATER LEVEL IN A TUBEWELL

3.3 *Air Pressure Line Method* — This consists of:

a) a tube positioned between casing and the outlet pipe and extending to below the depth of water,

b) a calibrated pressure gauge graduated in metres of water or in MN/m^2, and

c) an air pump and non-return air valve.

All above items should be adjusted as shown in Fig. 2. For example, if water level *'L'* is to be determined, air is pumped into the air tube, until maximum reading is obtained on the pressure gauge. The complete air tube will be filled with air and the pressure reading corresponds to *'A'*. At the time of setting, distance *'B'* should be noted. The required depth *'C'* will be the difference of *'B'* and *'A'* readings.

4. Verticality and Alignment

4.1 If a turbine well pump is to be installed in a well, the well should be true to line from its top to a point just below the maximum depth at which it is proposed to set a pump. A tubewell out of alignment and containing kinks and bends or cork-screws should be rejected because such deviations cause severe wear on the pump shaft, bearings and discharge casing and in a severe case, might make it impossible to get a pump in or out. If an air-lift or a suction pump is used for pumping, alignment is not so important and the same is applicable to the submersible type of pump.

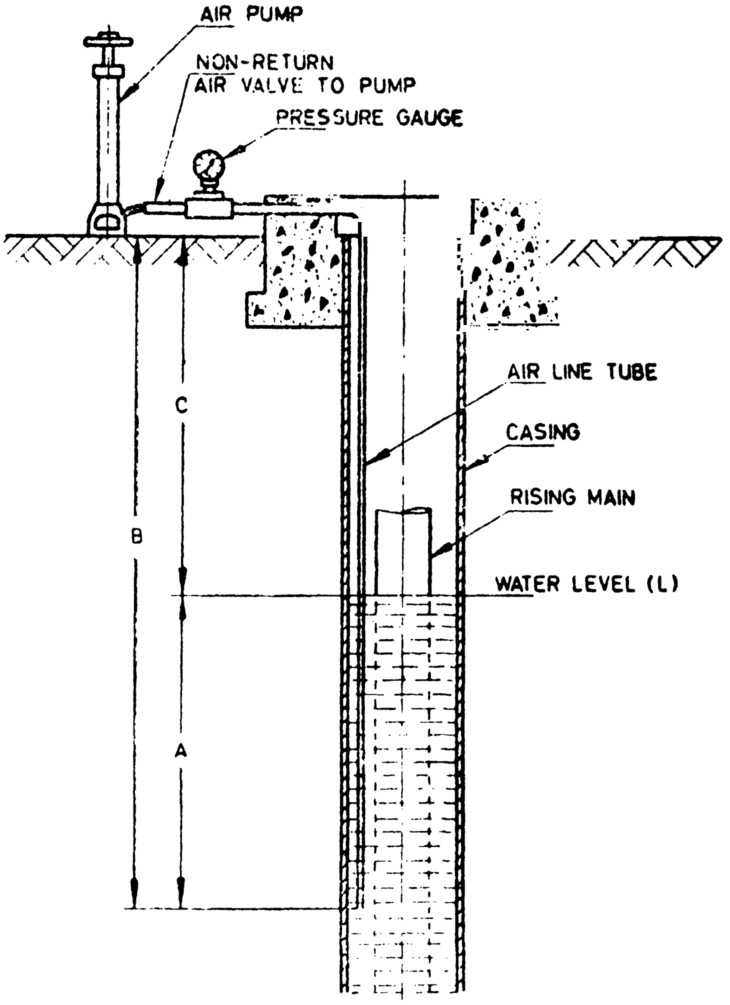


FIG. 2 AIR PRESSURE LINE APPARATUS FOR DETERMINING THE WATER LEVEL IN A TUBEWELL

4.2 In case of gravel-shrouded tubewells if the pipe assembly is found inclined in a slant position before completing the gravel pack, the assembly should be pulled in a desired direction by suitable methods with a view to rectify slantness and bringing the pipe assembly within the permissible limits of verticality. The gravel pack should be completed immediately after the verticality has been tested and rectified.

4.3 The verticality of the tubewell shall be tested by using plumb or plunger *E* (*see* Fig. 3) 6 mm smaller in diameter within the inside diameter of the well casing. The plumb may be made from a piece of sheet steel or a short piece of pipe. Whichever is used, it shall be heavy enough to keep the plumb line taut. The hub of the ring shall not be solid as the water shall pass through it as it is lowered in the well. The hole *F* from which the plumb line *A* passes shall be in the exact centre of the ring. Knots or marks shall be made every 3 m on the plumb line to indicate the depth to which the ring has been lowered in the well. The plumbing shall be suspended from the guide pulley where it shall be at least 3 m above the top of the well. The guide pulley is fixed on a tripod or frame *B* as shown in the figure. The vertical centre of the pulley shall be so located that the plumb line *A* comes off its outer edge exactly over the centre *D* of the well casing. The method of recording the results shall be as shown in Appendix A.

4.4 For tubewells encased with pipes up to 350 mm diameter the verticality of the tubewell shall be measured in terms of clear cylindrical space available within the housing pipe after the construction of the tubewell.

4.4.1 Verticality of the tubewell shall have a deviation so as to provide clear cylindrical space not less than the clear cylindrical space available in a hypothetical tubewell of the same size but having deviation of 10 cm per 30 m in one direction and in one plane only.

4.4.2 The verticality of the tubewell is to be tested as given in **4.3**. After the necessary computation is made, cross sections of housing pipes at different depths are drawn on a graph and clear cylindrical space is determined. This cylindrical space of the actually constructed tubewell shall be referred as *'G'* in the following paragraphs.

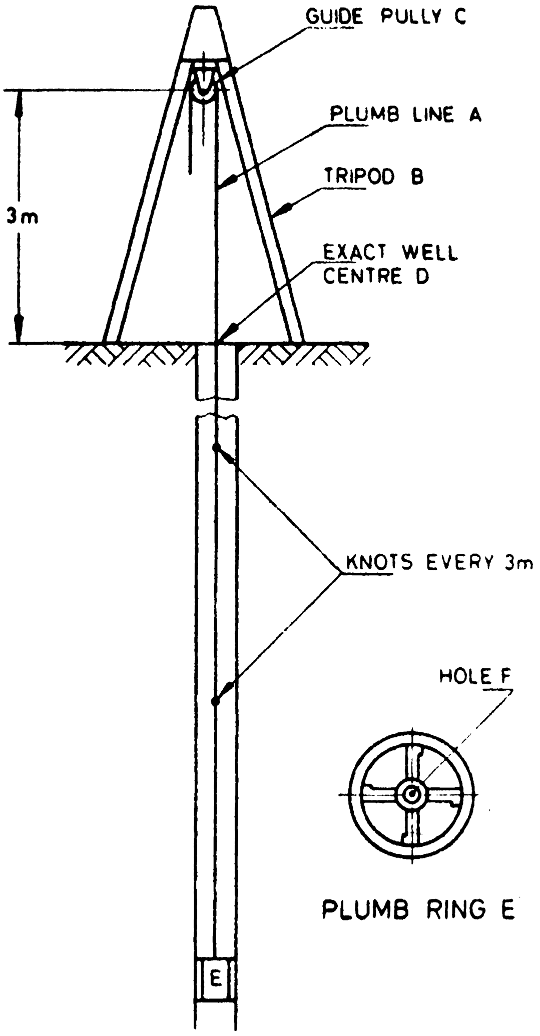


FIG. 3 METHOD OF PLUMBING A WELL

4.4.3 Cross sections of hypothetical tubewell identical in dimensions to the actual tubewell but having deviation of 10 cm per 30 m in one direction and in one plane are drawn on the graph sheet and the minimum allowable cylindrical space '*H*' is determined.

4.4.4 If cylindrical space '*G*' of the actually constructed tubewell is equal or more than the cylindrical space '*H*' of the hypothetical tubewell (having deviation 10 cm in 30 m in one direction or one plane) the tubewell actually constructed shall be considered within the permissible limits of verticality as given in this standard.

4.4.5 As an example cross sections of two tubewells G_1 and G_2 having 300 mm diameter of housing pipe have been drawn after computation of verticality results in Fig. 4 and Fig. 5; while Fig. 6 shows the cylindrical space '*H*' of hypothetical tubewell having deviation of 10 cm per 30 m depth of the tubewell. It will be noticed that space G_1 is more than space '*H*', while space G_2 is less than the space '*H*'. Therefore, tubewell G_1 shall be considered within the limits of verticality while G_2 is not within the limits of verticality as per the provisions of this standard.

5. Testing for Yield and Drawdown

5.1 The drawing off of water through a tubewell results in a lowering of water level. This 'drawdown' creates a hydraulic gradient in the water bearing material with the result that underground flow into the tubewell takes place. The rate of inflow depends upon the hydraulic gradient, permeability and saturated thickness of water bearing material and of tubewell construction.

5.2 After the well has been completely constructed and cleaned out and the depth of the well accurately measured, this test should be carried out.

5.3 This test is conducted by installing a test pump in the tubewell temporarily and pumping out water. At each rate of discharge, pumping is carried out at least for 30 minutes. If the water level and discharge are found to be fluctuating, development is carried out for some more hours, until the discharge becomes steady and sand content is within tolerable limits. The specific capacities of the well for various pumping rates is computed based on drawdown test data. Discharge may be measured by any method detailed in **13.7** of IS : 5120-1977 'Technical requirements for rotodynamic special purpose pumps (*first revision*).'

5.4 Since the yield is influenced by a number of factors such as geological formation, rainfall, neighbouring tubewells, etc, the pumping rate shall, in general, not exceed 60 percent of the yield determined by test. It is recommended, however, that geological advice should be obtained on the percentage to be adopted for each location.

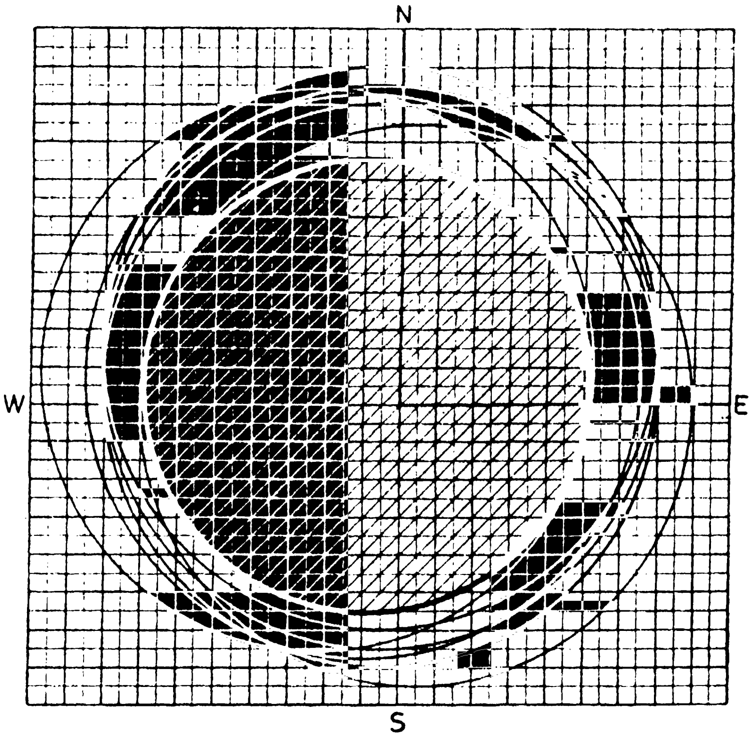


FIG. 4 G1

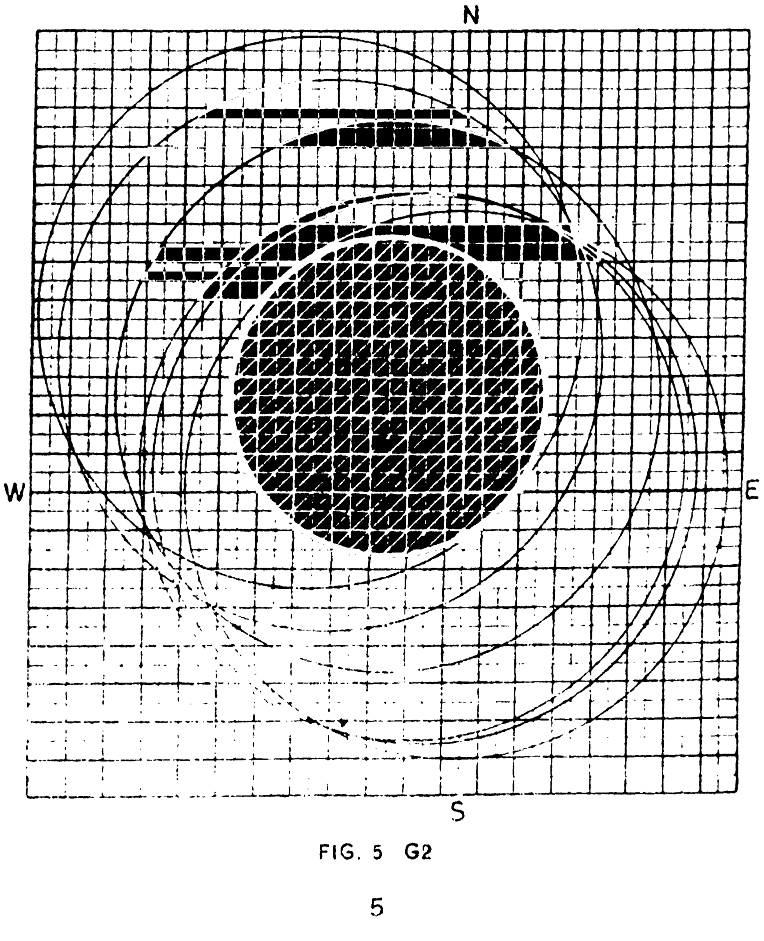


FIG. 5 G2

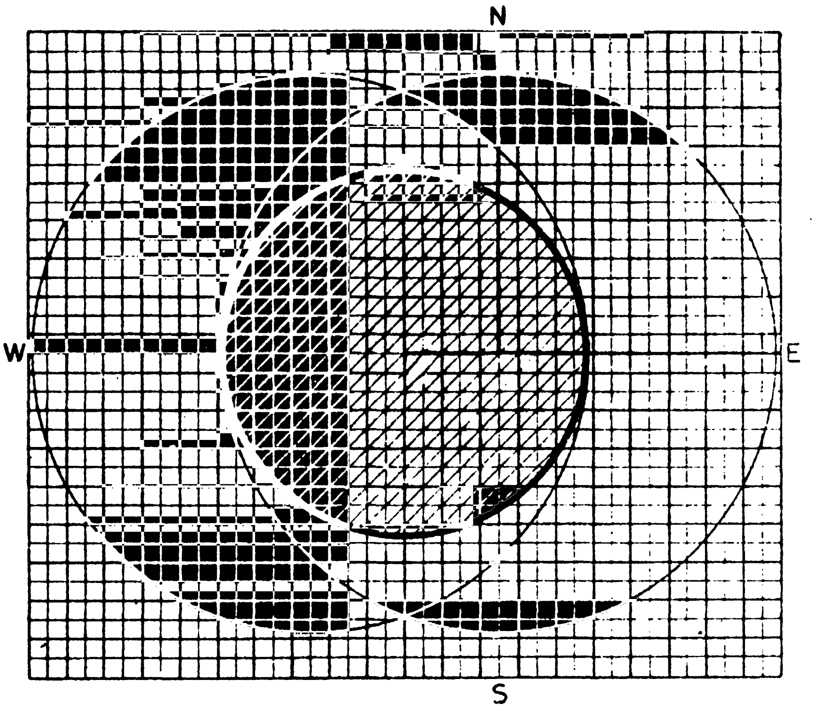


FIG. 6 H

6. Quality of Water

6.1 In the construction of the well, due precautions shall be taken by the drilling agency to maintain the premises in a sanitary condition and to avoid as much as practical, the entrance of contaminated water into the safe water bearing formations. Any water or materials used shall be free of contamination and, if their nature permits, should be adequately disinfected with chlorine before use. The slush pit should be constructed so that no material therefrom will enter the well, except mud reused when the construction is by rotary method. In such cases the slush pit and mud return channels should be protected against contamination from surface water or any other sources.

6.2 Water shall be collected during aquifer performance test and analysed chemically as desired by the owner, for different constituents depending on the ultimate use to which water will be put.

7. Handing Over of Tubewell

7.1 The followng information should be furnished by the testing agency to the owner on completion of testing of the tubewell:

a) Results of the tubewell depth and water level measurements,

b) Report on the chemical and bacteriological analysis of water, and

c) Results of development and drawdown test as given in Table 1.

TABLE 1 TEST RESULTS

A. *Normal Test*

Sl No. (1)	Rated Discharge (2)	Depression at Rated Discharge (3)	Specific Yield 2/3 (4)	Total Hours Run (5)	Sand in ppm at End of Test (6)	Static Water Level (7)	Pumping Water Level (8)

B. *Discharge at 1·2 times normal yield or 1·5 times the normal depression*

Specific Yield Discharge Drawdown (1)	Total Hours Run (2)	Sand in ppm at End of Test (3)	Static Water Level (4)	Pumping Water Level (5)

7.2 A typical *pro forma* is given in Appendix B to furnish the details given in 7.1.

APPENDIX A

(*Clause* 4.3)

VERTICALITY TEST REPORT

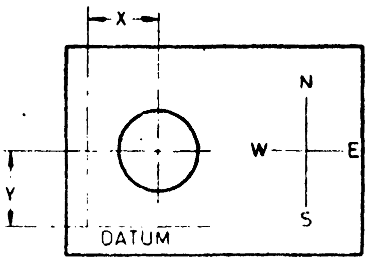
Name of Work: ....

Pump Serial No. ....

Conducted by: ....

In the presence of: ....

Date: ....



I.D. of well: ....mm

O.D. of disc: ....mm

Disc correction ....mm

Point of suspension...m above top of well

Static water level ....m

Depth of well housing ....m

Depth in m Below Top of Tubewell	Readings from Arbitrary Datum		Deviation from Vertical at Top of Tubewell				Calculated Deviation from Vertical at Respective Depth				Calculated Deviation from Vertical at Respective Depth Adding Disc Correction				Resultant Deviation Remarks and Its Direction
	X	*Y*	*N*	*S*	*E*	*W*	*N*	*S*	*E*	*W*	*N*	*S*	*E*	*W*	
O			O	O	O	O	O	O	O	O	O	O	O	O	O

Signature of Customer.............................. Signature of Tester..............................

APPENDIX B

(*Clause* 7.2)

INFORMATION TO BE FURNISHED BY TESTING AGENCY TO OWNER ON COMPLETION OF THE TESTING OF TUBEWELL

1. Agency conducting the tests..
2. Location of tubewell..
3. Date of starting...
4. Date of completion...
5. Total depth of tubewell..
   Method adopted..
6. Depth of water level...
   Method adopted..
7. Results of verticality and alignment test...
8. Drawdown test: Time of test ....
   Speed rev/min ....Discharge..............................Period run.......................
9. Rated discharge in P/min ....
10. Depression head of the production well...
11. Sand contents in ppm at the rated discharge after 20 minutes of the start of the pump or 20 percent in excess of the rated discharge if 50 percent extra depression cannot be arranged............
12. Recommendation with regard to a suitable pump...
13. Further details appended:
    Chemical and bacteriological analysis of tubewell water
14. Remarks:
    Owner ....Tester ....

EXPLANATORY NOTE

This code of practice was first published in 1964. In this revision, the standard has been split up and the requirements of tubewell construction and tubewell testing have been covered in separate parts. Thus IS : 2800 (Part I)-1979 'Code of practice for construction and testing of tubewells: Part I Construction (*first revision*) ' is a complimentary standard. Moreover, the requirements of aquifer performance test covered in 1964 version have been omitted in this standard.

In the preparation of this standard, assistance has been derived from the following:

AWWA A 100-58 Deep Wells, issued by American Waterworks Association

S.A.B.S. 045-1960 Code of practice for testing water boreholes